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FOOD AND NUTRITION INVESTIGATIONS OF THE AGRICULTURAL EXPERIMENT STATIONS, 1945

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EXAMPLES OF RESEARCH RESULTS

Natural color in both frozen and dehydrated peaches and apples was preserved by treatment with sodium bisulfite in Tennessee station experiments. The bisulfite was added in minute amounts to the sugar sirup used for packing the frozen fruits. Dried fruits dipped for 2 minutes in a 2-percent solution had better color than by the old method of exposing them to sulfur dioxide for 30 minutes, and the stifling fumes of burning sulfur were avoided. Adding small amounts of citric or phosphoric acids to the sugar sirup helped to preserve both color and flavor in frozen peaches and apples.

The southern muscadine grape, unsuitable for shipping fresh because of the tendency to "leak" and for canning because of bitterness in the hulls, has been found to be excellent for freezing preservation by a process developed by the Georgia station. The method includes deseeding, removing the excess tartness of the hulls, tenderizing the hulls, mixing with sugar, packing in cartons, and freezing. Only the seeds are removed. The product has an excellent bouquet; is suitable for pies, shortcake, cobbler, sherbet, ice cream, and sundaes; and may be cooked into jams and preserves. It is already being produced commercially.

Prevalence of dietary deficiencies, including pellagra, anemia, and calcium deficiency, associated with the large-scale consumption of corn meal and grits in the State, led the South Carolina station to research directed to the enrichment of these products with the deficient vitamins and minerals. Inexpensive automatic feeders developed by the station for attachment to corn mills have been installed by 67 mills, with resulting distribution and consumption of some 200,000 pounds of enriched corn meal. The station also developed a low-cost enrichment mixture containing niacin, iron, and calcium.

Discoloration in sweetpotatoes during processing had been shown in former work by the Maryland station to be caused by enzyme action. Since this discoloration appeared to be associated with lye peeling, research studies were conducted to eliminate discoloration under processing plant conditions. The station found that discoloration can be practically eliminated by preheating the sweetpotatoes for 30 minutes in water at 125° F., provided the initial temperature of the potatoes is at least 60°. If this treatment is used just prior to lye peeling, the temperature of the boiling lye then inactivates the enzyme. Application of the find-

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ing during processing for dehydration resulted in the saving of several million pounds of sweetpotatoes in the spring of 1945.

Wyoming housewives were helped through the sugar shortage by information from research of the Wyoming station on how to substitute honey and sirup. Honey was excellent in canning pears and apples, whereas dark corn sirup was best with blue plums. Crystal sirup was satisfactory with most fruits. Honey also proved excellent in cookies and fruit cake. It kept them moist in semiarid high altitudes.

Dates, recognized as rich in sugar and high in energy value, were studied by the Arizona station as to their vitamin content. Chemical analyses showed them to contain no ascorbic acid and little carotene, but to furnish 0.10 milligram each of thiamine and riboflavin per 100 grams of date pulp. Thus servings of four to six dates would provide as much of these two vitamins as common servings of other fruits.

The high ascorbic acid content of papayas and guavas is attracting wide attention. Utilization of the vitamin from these common Hawaiian fruits in tests with 14 human subjects by the Hawaii station was found to be similar to their utilization of pure synthetic ascorbic acid. A single serving of either fruit, both inexpensive and abundant in the islands, could provide all the ascorbic acid needed by the body to meet a day's requirement.

Losses of vitamin C in fruit and vegetable juices were found by the New York State station to be dependent upon the temperature of storage. At 45° C. as high as 60 percent of the ascorbic acid in fortified apple, strawberry, raspberry, or sauerkraut juices is destroyed in a month. Losses at 37° and 32° are less, whereas juices stored at 1°, 10°, or 21° show very little loss. Undesirable changes in color, flavor, sugar, and pectin accompany losses of vitamin C at high temperatures.

Berries are grown in large quantities in Oregon for home consumption and commercial uses. Hence information on vitamin C is important. The Oregon station found wide variation among strawberry, raspberry, and blackberry varieties and selections in breeding experiments from a low of 50 to a high of 125 milligrams of ascorbic acid. Several strawberry selections had very high potency. Heredity rather than environment determined vitamin C content.

Kale, heavily frosted in the field, suffered serious losses of vitamin C, according to findings at the Delaware station. Whether the growing of kale under favorable climatic conditions can restore these losses should be given consideration if this commodity is to be grown as a late-season source of vitamin C in the diet.

Whole brown rice was found by the Arkansas station to be a much better source of the vitamins thiamine and riboflavin and a slightly better source of inositol and pyridoxine than white polished rice. Losses of nutritive properties in cooking were small in all types of rice when a double-boiler type of cooker was used. Large losses occurred in open vessels. There were no significant losses in food values after 2.5 years in cold storage.

INTRODUCTION

Investigations dealing with the conservation of foods and with problems of insuring conservation of their nutritive values were well under way as a contribution to the war effort and have been continued within the year. Many, but not all, of these studies have been conducted as a part of a program of work carried out under the National Cooperative Project on Conservation of the Nutritive Values of Foods, first noted in the 1943 report. The studies on methods of food preservation and on factors affecting food values have constituted the major part of the food-research program of the stations. However, a number of studies have dealt with the relation of food intake to nutritional well-being and with the associated problem of food habits. A few investigations have been concerned with the use and performance of household equipment utilized for food preparation.

The extent of these researches on foods and nutrition does not permit discussion of all the work that has been done in the year. The selected studies outlined briefly in the examples cited above and in the following pages will serve, however, to illustrate the nature and scope of the investigations and some of the results.

FOOD PRESERVATION

Freezing as a means of food preservation offers certain advantages which make this method very attractive. Chief among these is the fact that the palatability and nutritive value of the fresh food is more nearly retained by this method than by others. In trials at the Massachusetts station, in which snap beans, cabbage, carrots, and sweet corn were frozen, canned, dehydrated, and salted by home methods, freezing appeared to yield the most acceptable product from the standpoint of palatability, flavor, texture, and color. Retention of ascorbic acid on the basis of the cooked, ready-to-serve product was about the same for frozen and canned products.

Asparagus, carrots, peas, and spinach, precooked in steam, puréed, sieved, and preserved experimentally by canning, freezing, and dehydrating, were tested at the California station. The frozen products were the best from the standpoint of general palatability, appearance, and retention of ascorbic acid, thiamine, and riboflavin content. The canned products, lower in vitamin content than the frozen, were quite acceptable, and the dehydrated products were also good but tended to deteriorate more quickly during storage unless packed in a vacuum.

A circular prepared by the Kansas station as an aid to prospective buyers in the selection, use, and care of home frozen-food cabinets lists the disadvantages as well as the advantages of home food preservation and points out that superior quality will not be attained in the frozen product unless care is taken to use fresh material of prime maturity and quality and to prepare and package it properly. While different varieties of fruits and vegetables showed marked differences in the suitability for frozen storage in tests at the Minnesota station and the Kansas station, yet, the methods of handling and degree of maturity were more important. Methods of handling, of course, differ somewhat from

product to product, and certain foods present special problems. To meet this situation, the Kansas circular, referred to above, includes instructions for preparing and packaging individual foods, including various fresh fruits and vegetables, meats, eggs, butter, and miscellaneous precooked foods.

One of the special problems in preparing frozen apples, peaches, and apricots is the prevention of brown discoloration. To inactivate the enzymes responsible for the darkening of frozen apples during storage and after thawing, the New York State station found cold immersion in a solution of sulfur dioxide or of sodium sulfite or steam blanching to be satisfactory treatments. Sodium bisulfite was found by the Minnesota station to be superior to sodium sulfite in preparing pie apples for freezing, although this did not hold true for apples to be used for sauce. The Kansas station found thiocarbamide, one teaspoonful to a quart of water, or sodium sulfite, one-half teaspoonful per quart, to be effective in preventing browning of peaches if the prepared fruit was dipped into the solution and drained before packing in the sirup. Crystalline ascorbic acid, three teaspoonsful per gallon of sirup, improved the color and quality of frozen peaches and apricots, in tests at the Minnesota station.

Selecting a variety particularly adapted to freezing will help to insure quality in a frozen fruit or vegetable, or, on the other hand, it may be necessary to adapt the method to the variety. Thus, cultivated blueberries should not be blanched before freezing according to recommendations of the New Jersey station, since trials conducted there showed that blanching unfavorably affected the appearance and edible quality of the blueberries. On the other hand, wild blueberries and certain varieties grown at the Georgia station were improved by blanching before freezing, this treatment preventing the development of woody texture upon storage of the frozen berries.

Proper preparation of foods as to size and shape of package, choice of packing medium and amount of wrapping materials, and attention to location of the packages in the freezer and the amount of products being frozen at one time are factors that affect the freezing rate. These, the Pennsylvania station suggests, are points to be considered by the operator in the economical use of the freezing unit. The speed of quick freezing of vegetables has little or no effect on their quality, however, according to the New York State station, and the Iowa station found that the palatability of frozen broilers was not affected by the rate of freezing.

Once frozen, there is a constant turn-over of foods in the frozen storage cabinet. In preparing a schedule of changes of food in the home cabinet, the Kansas station considered the seasons when different foods are available for freezing and the storage life of the various products. Pork loin roasts, for example, kept well for only 16 to 22 weeks at temperatures from —9° to —18° C., in tests at the Minnesota station; after that period the fat developed an undesirable flavor and aroma, although the lean changed flavor at a slower rate and retained its tenderness and juiciness. Pork chops wrapped in two thicknesses of good locker paper and stored at 0° F. in trials at the Oregon station gradually decreased in desirability, but kept satisfactorily for 10 months.

The possibilities of the home freezer have not yet been fully explored, and new possibilities and new frozen products can be expected. Some of the new frozen products developed for home freezers in recent experimental work at the Minnesota station include unpeeled sliced eggplant frozen after dipping in water acidified with lemon juice and blanching; squash purée prepared from dry types of squash for use in pumpkin pies; sweetpotato slices prepared from baked, cooled sweetpotatoes peeled and treated with diluted lemon juice and a coating of sugar; and eggs, frozen separated or mixed, and treated with light-colored corn sirup to prevent undesirable coagulation of the yolk in freezing.

Interest in the freezing preservation of cooked foods led the Georgia station to study the suitability of fruits, vegetables, meats, and combination dishes for freezing after being cooked and to study the best methods of preparation, the most desirable types of containers, and the most satisfactory method of serving. The results of this study suggested that a wide variety of these foods could be satisfactorily cooked and frozen, but that it was much more difficult to hold the volatile flavors during preparation, packing, freezing, storing, thawing, and serving cooked foods than was the case with the frozen raw foods. The flavor of blueberries, raspberries, blackberries, apples, plums, and grape products was improved if the fruits were preheated and packaged as a "solid pack" before freezing. Precooked vegetables if packaged as "loose pack" lost fresh flavor and aroma and developed a "warmed over" flavor. This could be overcome, however, by packing them solid thereby eliminating air. Boiled, baked, or roasted meats, but not fried meats, could be satisfactorily frozen. The tests suggested further that a wide variety of combination dishes, sauces, bakery products, canned foods, preserves, pasteurized butter, pasteurized cheese, and precooked dehydrated products may be profitably and satisfactorily preserved by freezing.

Canning, which found wide application in wartime conservation of Victory garden crops and local market surpluses, will continue to be the method of choice in many homes. In the interest of safe home canning, the Massachusetts station has investigated the cause of spoilage observed in some home-canned foods and has made a study of processing times adequate to sterilize the packs without overcooking them. Preliminary to the study, an extensive review of the literature was made to obtain all the information available on botulism in relation to home canning. This type of food poisoning, although not very common, is by far the most spectacular (often fatal). The well-rounded review of the subject, presented in the Massachusetts station bulletin makes it clear in summary that botulinum organisms are widely distributed in nature and are not apparently confined to certain geographical areas, so that canning techniques employed in any region must be adequate to destroy chance spores of the organism. For nonacid foods, adequate sterilization is insured only by means of a pressure canner in good operation. Any nonacid foods canned without a pressure canner, or in a pressure canner incorrectly used, should never be tasted until they have been boiled for 10 to 20 minutes.

The Illinois station also mindful of this problem of botulism,

made a survey of the soils of its own State to determine the incidence and distribution of *Clostridium botulinum,* the organism responsible for the development of the botulinum toxin. Examination of the soil samples resulted in obtaining toxic cultures from soils of about one-fourth of the counties in Illinois. These results emphasized anew the necessity of adequate processing of foods in home-canning operations.

The Massachusetts station continued its investigation by making a careful survey of 90 families to determine the spoilage in home-canned foods and found it to amount to about 2 percent. Laboratory examination of samples, sound and spoiled, submitted by 300 families indicated that about three-quarters of the home-canning spoilage was due to understerilization and one-quarter to improper sealing; however, none of the samples contained any botulinum toxin. The study, continued further, utilized vegetables packed in home-canning jars and applied to them the exact methods long used by commercial canners to determine process times for their products. The results showed that water-bath processing, commonly used in the home, was not satisfactory for nonacid vegetables. By this method of sterilization packs of these vegetables inoculated with certain spoilage bacteria found in home-canned foods required from 5½ to 12 hours for adequate processing. In a pressure cooker at 240° F., these packs were found to be adequately sterilized well within the processing times recommended by the Department of Agriculture for home canning by this method.

Dehydration of fresh foods, as a means of greatly reducing their volume and converting them to products capable of being held for considerable periods, required research and development toward meeting the wartime food demands of the armed forces. One of the problems in the realm of food dehydration, that of preventing graying of potatoes, was investigated by workers at the New York (Cornell) station. They found that the chemical reactions which result in the darkening of boiled potatoes are the same as those causing graying of dehydrated potatoes; that whether a potato darkens during dehydration is a quality inherent in the potato itself; and that the actual drying process has little or nothing to do with the occurrence of this trouble. Observations as to the relation between the acidity acquired by the potato during storage and its graying tendency led to the development of a procedure for preventing graying during dehydration. The method, which worked well in commercial as well as in laboratory practice, involved slight acidification of the peeled whole or diced potatoes, either during or after blanching, with water acidified with orthophosphoric acid to a reaction of pH 4.0.

The ease of application, the short period of treatment required, the harmlessness of the dilute acid, low cost, lack of alteration of flavor, and production of a dehydrated product of uniform color with no darkening were the practical advantages of the process. Citric, acetic, lactic, or sulfurous acid or sodium dihydrogen phosphate could be satisfactorily substituted for the phosphoric acid.

An objectionable darkening of dehydrated sweetpotatoes which resulted in rejections by the Army was investigated by the

Kansas station as to cause and prevention. Working with sweetpotatoes obtained from various farms in western Missouri and the Kaw River Valley of Kansas, the station obtained a satisfactory dried product with bright color by pretreatment of the sliced tissues with 0.5 percent sodium bisulfite solution followed by steam blanching and dehydration. By means of this treatment, the oxidizing enzyme responsible for the darkening was inactivated. Blanching in steam alone for 4 minutes at 200° F., although helpful, did not entirely prevent the defect.

Powdered, dehydrated tomatoes were prepared on an experimental scale at the California station by dehydrating the halved or sliced tomatoes stepwise in a forced draft drier. At the temperatures that could be safely used, the moisture could not be reduced below 10 percent, and final drying to a satisfactory moisture content of 5 percent had to be accomplished in a laboratory vacuum oven. The dried brittle product, from both sulfured and unsulfured tomatoes, when ground, sieved, and packed varied in quality and vitamin retention when stored for various periods under different conditions. Sulfuring and vacuum packing, however, had a favorable influence on retention of color and flavor and vitamin values. The powdered dehydrated tomato and also blends of tomato with split peas, corn, or lima beans dried in an experimental-scale drum drier are considered promising for dehydrated soups.

Cold-mix dehydrated fruit spreads were developed for use in Army field rations through joint research of the Office of the Quartermaster General, U. S. Army, and the Delaware station. The study was designed to determine the thickening characteristics of various combinations of dehydrated fruits, sugars, and hydrocolloids in powdered mixtures which, when moistened with water would almost instantly and without application of heat, assume the character of a fruit jam. The basic flavor ingredient of the powdered mixes was dehydrated fruits, such as apples, apricots, cherries, cranberries, figs, pineapples, prunes, raspberries, or tomatoes; this was combined with (1) a sweetening agent, preferably lactose, mannitol, or dextrose since these sugars are less sweet than sucrose and did not mask the fruit flavor; (2) a thickening agent, such as pectinic acid, various commercial extractives of Irish moss, locust bean gum, and others; and (3) certain salts and acids. Tests to determine the behavior of the various thickening agents, the degree of sweetness desirable, and the resistance of the mixtures to caking as a result of moisture absorption under various conditions of packaging led to the development of several economical formulas which thickened rapidly to a desirable consistency when the proper amount of water was added.

The operational aspects of dehydration were the subject of a number of investigations. The Massachusetts station, for example, worked out a procedure for evaluating the operational efficiency of home dehydrators, based on the pounds of water evaporated and the kilowatt hours of electricity used. The best operating efficiency in home dehydrators was observed in those of the forced draft type since these required no rotation of the trays and showed the shortest drying time of the three methods used. Nat-

ural draft dehydrators, if properly designed, also yielded good results, but the drying time was prolonged, temperature control required watching, and trays had to be rotated at intervals. Oven drying proved least satisfactory because of the difficulty of controlling the temperature, variations of temperature in different parts of the oven, and the necessity of frequently shifting and rotating the trays.

Data obtained by California investigators in observations on products from commercially operated tunnel dehydrators led to the suggestion that the drying be started with high temperature and high air velocity and that the partly dried product be placed in a second tunnel or other drier to be finished in air at lower temperature and velocity than in the primary tunnel. It was also suggested that trays of the partly dried product be doubled up, or trebled up in some cases, to permit one secondary tunnel to serve two or three primary tunnels.

Blanching by brief exposure to flowing steam or boiling water is an essential preliminary step to actual dehydration or freezing processes in order to inactivate enzymes which may cause deterioration of flavor and destruction of vitamins during storage of the product. These blanching treatments sometimes damage the texture of vegetables and leach out some of the water-soluble vitamins. Results obtained in laboratory scale tests at the New York State station indicated that electronic heat produced by a shot of high frequency electricity may be used in place of steam or hot water to inactivate the enzymes. By resorting to electronic blanching, the loss of ascorbic acid in the blanching of cabbage, for example, was reduced to 3 percent and handling of the material was greatly simplified.

Brining, pickling, and smoking are time-honored methods of food preservation that recommend themselves not only for the variety they offer in winter food but more especially because they require the minimum of equipment in their application. Sauerkraut, one of the most popular of the brined fermented products, was made at the North Carolina station from locally grown green-colored market-type cabbage. The product, whether manufactured on a large scale or made in quart-jar lots as for home use, was of very satisfactory quality; because it was made from green cabbage it had a yellowish color which was presumed to indicate a higher carotene content than that of the usual white cabbage product. The possibility of kraut manufacture from seasonal surpluses in market cabbage opens the way to a more profitable future for cabbage growers in the region and at the same time provides a palatable product for the consumer. For making kraut at home, the station in cooperation with the Department developed a procedure so simple that it can be used even in a kitchenette. The kraut thus prepared can be kept for a few weeks if sealed tight and kept in a cool place or it may be canned for longer storage.

Mindful of the nearly 5 million pounds of vegetables salted in Michigan in 1943, the still larger production in 1944, and the prospects of a very large crop of vegetables in 1945, the Michigan station investigated processes for salting beets, carrots, corn, green

beans, and spinach as a method for preserving vegetables in large quantities for soup making and for institutions using considerable amounts of vegetables. Bacteriological tests, vitamin determinations, and observations on the influence of salting on the color, flavor, and appearance of the salted vegetables showed these products to compare very favorably with the canned products prepared from the same lots of the raw vegetables. Certain variations in procedure were tried, but the best products, as judged from their quality after cooking, were those put up in an 18-percent brine, the whole kernel corn, the snap beans, and the dried carrots after preliminary blanching, the spinach and unpeeled beets without blanching. The use of 0.3-percent acetic acid in the brine improved the carrots, and the spinach was satisfactory with or without the addition of the acid. The brined beets were white on the outside to a depth of 2 or 3 millimeters.

As one way to conserve sugar in pickling, the New York State station suggests that the pickling solution or sirup from home-made or commercially processed sweet pickles be used again. This reuse of the pickling sirup always gave satisfactory results in the tests conducted, although the second batch of pickles was never as sweet as the first lot unless more sugar was added. It was found to be a good practice to make up about a third of the amount of pickles wanted, as sweet pickles, using the full amount of sugar called for in the recipe, the remainder of the pickles then to be packed in a solution having the same amount of vinegar, salt, and spices, but much less sugar. As the sweet pickles are consumed, the unsweetened pickles can be placed in the left-over solution and allowed to stand for a few days when they will absorb much of the sugar left in the original pickling solution.

Directions for the home preservation of fish by pickling and smoking and for preparing smoked-fish dishes are included with other fish recipes issued by the Michigan station and by the Iowa station. These tested recipes were assembled and developed in the interest of making greater use of an abundant but less generally used food supply. In connection with these studies on the locally available kinds of fish, information was obtained on weights and yields of refuse and dressed fish.

NUTRITIVE VALUE OF FOODS

A review of the year's reports indicates that many foods, probably some 75 particular commodities, including fruits, vegetables, meats and fish, cereals, eggs, and dairy products, have been concerned in the many investigations of the various experiment stations. Some of the studies were of the survey type to obtain information on the relative values of a large number of foods. Of this type were the Pennsylvania station study of the vitamin content of some tropical fruits, their juices, and nectars; the investigation by the Florida station of the vitamin A and C activity of Florida foods; the Nebraska station studies on the riboflavin content of cheese; the Wisconsin station experiments determining the choline and pyridoxine content of meats; and the California station analyses to determine the cholesterol content of foods. Most of the studies, however, were concerned with some special

factors affecting food values, such, for example, as the effects of cooking, processing, storage, and natural variations on the vitamin content of foods.

The effect of natural variations on food values involves consideration of the various factors in operation as the plant, or animal, is growing. In this connection, the influence of variety, of stage of maturity, of the part eaten, of sprouting, and of feeding practices was investigated and are discussed briefly as follows:

Variety may or may not exert a pronounced effect on the nutritive value of fruits and vegetables, and its influence may be masked by other factors. In trials at the Rhode Island station in which 11 varieties of snap beans, 9 green and 2 wax, all grown under identical conditions, were analyzed for their ascorbic acid and carotene contents, no variety appeared outstanding for ascorbic acid content. Moreover, although some varieties consistently ranked higher than others in carotene content, the differences between varieties were not marked. In general, the highest analyses for ascorbic acid in the green varieties were slightly higher than those for the 2 wax varieties, although some green varieties were lower than the wax. The wax beans had little more than one-third as much carotene as the green beans.

In tomatoes of 3 varieties, Marglobe, Rutgers, and Gulf State Market, grown from the same seed source at the Georgia station, Louisiana station, and Virginia Truck station in a cooperative study, no varietal differences in ascorbic acid could be shown. In the Rhode Island experiment in which 28 varieties and hybrids of tomatoes were compared for ascorbic acid content, there were large differences between the low and high results at each sampling, but many varieties were inconsistent in their relation to others at different sampling dates. Certain varieties, however, such as Comet, Vetomold, Pan American, and Marglobe, were consistently among the high-ranking varieties, with ascorbic acid values of from 19 to 24 milligrams per 100 grams, while other varieties were low (around 12 milligrams per 100 grams) or intermediate.

The Maine station on the basis of trials over several seasons with 29 varieties of tomatoes concluded that ordinarily a superior variety maintained its superiority even under unfavorable conditions. It was obvious from the data obtained that many of the varieties popular in home and commercial use were those on the lower level of ascorbic acid content. This fact together with the losses incurred in processing resulted in these tomatoes being less than a good source of this vitamin. The need for growing high-vitamin C varieties of tomatoes is emphasized.

In apples, ascorbic acid concentrations were related to varieties, according to the results of analyses of 13 varieties grown in the orchards of the West Virginia station and tested over a period of years. These apples ranged from 6.9 to 20.9 milligrams ascorbic acid per 100 grams. Ascorbic acid content as a varietal characteristic was also observed by the Iowa station in Iowa-grown apples. Willowtwig apples were surprisingly rich in this vitamin, about 25 milligrams per 100 grams, and retained it well over a 7-month storage period. This was in contrast to Jonathan apples, which

contained about 9 milligrams of ascorbic acid per 100 grams when freshly picked and tended to lose about half of this amount in the first 3 months of storage. The Willowtwig apple may prove useful in an apple-breeding program from the standpoint of improving the average ascorbic acid content of apples.

The high ascorbic acid values of strawberries and the varietal differences in content of this vitamin were observed in trials at the Maine station, where six high-ranking varieties were found to contain 83 to 96 milligrams per 100 grams, five intermediate varieties 65 to 76 milligrams, and three low varieties 46 to 61 milligrams per 100 grams.

The ascorbic acid content of 25 varieties of California-grown guavas as determined by the California station ranged from 55 milligrams per 100 grams in the Earle variety to a maximum of 529 milligrams per 100 grams in the Rolfs. Other varieties were intermediate usually with their own characteristic levels of the vitamin.

The part sampled must be considered in the laboratory in selecting a representative sample of the food for analysis. Such selection may also net returns in added nutritive value in preparing the food for table use. In the case of summer squash, for example, the Rhode Island station found that ascorbic acid was highest in the pith and seed portion, the seeds being about twice as high as the pith when analyzed separately. The rind was consistently and significantly highest in carotene in each of the three varieties tested. For maximum nutritive value, therefore, these summer squashes should be used in their entirety, texture permitting, in preparing them for table use.

In kale, as harvested for a study of vitamin C by the Maine station, the inner leaves were found to contain about 34 percent more ascorbic acid than the outer leaves. The leaves of celery, as another example, are far richer than the stalks in both carotene and ascorbic acid. Thus green (Pascal type) celery supplied to the Florida station by the Celery Investigations Laboratory contained 345 micrograms of carotene per 100 grams of outside stalks, 249 micrograms for the inside stalks, a trace in the hearts, and 4,508 micrograms per 100 grams of leaves; corresponding values for ascorbic acid in milligrams per 100 grams were 6, 9, 9, and 31. When bleached, the outside and inside stalks and heart contained only traces of carotene, while the leaves contained 4,500 micrograms per 100 grams of leaves; these four parts of the bleached celery contained, respectively, 10, 12, 20, and 37 milligrams ascorbic acid per 100 grams of fresh material.

Higher values for ascorbic acid in the heart portion were also observed by the Utah station in Utah-grown celery. The hearts and inner leaves of the fresh celery, Utah variety, contained 26.5 milligrams ascorbic acid per 100 grams, this being twice as much as was found in the outer stalks and about one-third to one-fourth as much as in the outer leaves. These same relationships but lower values were observed for celery of the Cornell variety. This difference in ascorbic acid content of leaves and stems was also observed in celtuce analyzed as freshly harvested at the Illinois station; the leaves, containing 41 to 55 milligrams ascorbic acid

per 100 grams, were 10 times as rich in this vitamin as were the stems which contained only 4 to 6 milligrams per 100 grams.

Maturity and ripening conditions often exert a marked influence on the vitamin values of foods. Carrots, for example, were planted by the Arizona station at two locations in the State in October, November, December, February, and March and harvested from each planting beginning with pencil size and extending through a 240-day growing period. With both varieties (Imperator and Chantenay) and in all plots carotene increased with the size of the carrots—and hence with age, maturity, and length of growing season—from 2 up to 20 milligrams per 100 grams fresh weight. Carrots from the south row of east-west beds always contained more carotene than those from the north row, indicating the influence of soil temperature on rate of growth. Also, carrots planted in October in the Salt River Valley at a higher elevation and, therefore, a cooler climate with longer chilling periods grew and increased in carotene content more slowly than those planted at the same time in Yuma. Carrots planted in the spring months, February and March, not only grew more rapidly, as expected, but carrots of the same marketable size were appreciably higher in carotene content. The New Mexico and Oregon stations also observed this increase in the carotene content of carrots with the growing season, the Chantenay carrots at the latter place synthesizing carotene most rapidly during the first 15 weeks of growth.

Potatoes harvested from green vines were observed by the Nebraska station to have exceptionally high ascorbic acid values. This was in line with the observation at the Idaho station that there was a distinct drop in ascorbic acid with maturity and subsequent storage.

Head lettuce (Boston), as analyzed by the Massachusetts station, proved to be a valuable source of carotene, riboflavin, calcium, phosphorus, magnesium, and iron and deserving of being classed as a protective food. Immature Boston lettuce, not yet starting to head, was found to have more riboflavin than the mature. The average of 0.124 milligram riboflavin per 100 grams of immature lettuce was over four-fifths as much as found in the same weight of milk from cows eating forage grown on similar soil.

The effect of sunshine on the vitamin storage in ripening oranges was observed at the Arizona station. Weight for weight, orange juice from navel and Valencia oranges picked from exposed sunny areas of trees in the experimental orchards contained more ascorbic acid than did juice from fruits picked from the shady areas of trees. In terms of total ascorbic acid per orange, however, this difference was materially offset by the fact that the oranges from the shady parts of the tree, the shaded center in particular, consistently attained greater size and weight and yielded more juice than the fruits exposed to the sun. These Arizona oranges, picked at marketable maturity, averaged, regardless of size, about 30 milligrams ascorbic acid per fruit for the navels and about 45 milligrams for the Valencias.

Sprouting cowpeas and mung beans was easily accomplished in

experiments at the Oklahoma station by placing the seeds between wet pads in 8-inch flower pots at temperatures between 70° and 80° F. Sprouts 2 to 4 inches long developed in 96 hours. Comparison of the amount of ascorbic acid and protein in the dry seeds with that developed in the sprouts indicated that both of these substances were formed in the sprouting process. The cowpea and mung bean sprouts contained, respectively, 4.6 and 5.3 percent of protein and 19.6 and 19.2 milligrams of ascorbic acid per 100 grams of fresh sprouts.

Feeding practice can measurably affect the vitamin content of pork according to results obtained in three independent studies. Data obtained at the Pennsylvania station, discussed in the section on animal products, showed that thiamine can be stored at a rapid rate in pork muscle when the pigs are fed extra thiamine and that these tissues can be saturated within 35 days or less. Experiments conducted at the Hawaii station showed that cooked lean pork from grain-fed hogs contained 50 percent more thiamine than similar muscle from garbage-fed hogs. In agreement with results obtained in previous years, the North Dakota station found that the feeding of supplementary niacin increased the niacin of the rib and of loin and ham. Discontinuing the niacin 34 to 47 days before slaughtering gave lower niacin storage than the continuous feeding. Feeding the supplementary niacin only the last 33 to 64 and 22 to 33 days before slaughtering produced storage approaching or equaling that in the group fed niacin continuously.

The effect of storage or holding on food values is to be observed in many instances, as in winter storage of vegetables, in the marketing of produce and in the holding of foods for home use. Idaho-grown Russet Burbank and White Rose potatoes, for example, showed a distinct drop in ascorbic acid with maturity and storage in Idaho station tests, and the winter stored potatoes had only approximately one-third as much as the immature tuber. A low storage temperature is to be avoided except as needed to maintain dormancy, the Nebraska station experiments showed. The ascorbic acid content of the potatoes for late winter use could be doubled or tripled by storing at high temperatures (50° to 60° F.) until sprouting began and then lowering the temperature to 40° to maintain dormancy. With this method, potatoes retained more ascorbic acid till early March than was retained till November 10 when 40° storage was used from harvest time in mid-October.

In winter storage of beets, the North Dakota station found, there was little or no real destruction of the ascorbic acid present although an appreciable amount of it changed from reduced ascorbic acid, the form in which about half of it existed in the freshly harvested beets, to the dehydro form. Arizona-grown sweetpotatoes of the Porto Rico variety held in pit storage apparently lost no ascorbic acid in the first month of storage, but showed losses of 16, 21, and 37 percent after 2, 3, and 4 months, respectively, according to the Arizona station. In this interval there was very little change of ascorbic acid from the reduced to the dehydro form, and the three varieties tested averaged about 26 milligrams ascorbic acid per 100 grams after 4 months of pit

storage. Carotene in these same sweetpotatoes showed no loss with storage and at the end of the 4 months averaged about 4 to 6 milligrams carotene per 100 grams in the Porto Rico variety grown in two different regions and about 2 milligrams per 100 grams in the Nancy Halls, which were from the beginning poorer sources of carotene than the Porto Rico sweetpotatoes.

Celery of two varieties received at the Utah station shortly after harvest was stored for 1, 2, and 3 weeks in a refrigerator at 40° F., being held wrapped in burlap which was moistened daily. Only slight change in ascorbic acid occurred in the celery in 2 weeks of storage, but in the third week a marked decrease in vitamin content resulted, amounting to 34 and 50 percent in the two varieties, respectively. In trench storage, the celery remained crisp and retained its flavor for 2 months, but lost 50 percent of its ascorbic acid.

Holding vegetables on snow ice for market display greatly preserved their vitamin value as well as their appearance and quality in trials conducted by the Michigan station. In two displays of vegetables at the local retail grocery the leaf lettuce, green beans, and spinach displayed for 8 hours on a nonrefrigerated sheet-iron rack lost, respectively, 22, 11, and 45 percent of their ascorbic acid, while similar lots held on snow ice lost, respectively, only 0,3, and 4 percent of their ascorbic acid.

Storage tests with freshly harvested strawberries, raspberries, and loganberry and blackberry crosses grown at the Oregon station showed that these berries lost none of their ascorbic acid at refrigerator temperatures for a few days, and only slight losses when kept at room temperature as long as the berries remained in good condition. At 85° F., however, the berries did not stay in good condition for long and at the end of 2 days the strawberries tested had lost a considerable part of their ascorbic acid.

Sliced tomatoes permitted to stand in the refrigerator, as is sometimes done in holding them over from one meal to the next, were found to show no perceptible change in ascorbic acid content, as compared with freshly sliced tomatoes, in a cooperative study of the Georgia, Louisiana, and Virginia Truck stations. Similarly, cut sections of cantaloup held in the refrigerator for 2 to 4 hours lost no ascorbic acid, according to the findings of the New Mexico station, but after 18 to 21 hours the loss amounted to 13 percent.

Milk in commercial half-pint bottles exposed to sunshine for two 30-minute and two 60-minute intervals in experiments at the Massachusetts station was found to lose its ascorbic acid very rapidly, for little if any was present after 30 minutes' exposure. The riboflavin disappeared more slowly, there being a 10-percent loss during 60 minutes' exposure on a rainy day and about 85-percent loss during exposure in bright sunshine for 120 minutes. These results show that milk allowed to stand for more than a short period on the consumer's doorstep exposed to strong light or sunshine is likely to lose a large amount of its ascorbic acid and riboflavin.

Dried eggs stored either loose or compressed in wax cartons for 6 months at 20° C. or lower retained 62 percent or more of

their initial vitamin A in tests conducted at the Indiana station. At 37° C. they retained only 30 percent. Compressing the dried egg powder prior to packaging failed to have any beneficial effect on the retention of vitamin A during storage. Eggs which had been sealed in tin cans retained about 75 percent of their potency regardless of storage temperatures.

Lists of foods suitable for storage in Hawaiian homes were prepared as an aid in meeting military and civilian food committee recommendations to Hawaiian families in 1940 and 1941. Precautions for storing the foods included instructions for fumigating brown rice, rolled oats, and whole wheat flour with carbon bisulfide by a household process to destroy insects. Tests at the Hawaii station showed that the cereals retained their original thiamine content after this treatment. The thiamine content of whole wheat flour treated with methyl bromide by a commercial process was likewise unaffected.

Samples of brown rice of five varieties obtained from two or more rice experiment stations (California, Texas, Louisiana, and Arkansas) and assayed at the California station when first received contained from 3 to 4 micrograms of thiamine per gram. After 6 months' storage at 68° F. under good conditions, the brown rice lost 0 to 30 percent of its thiamine. Rice bran and rice polishings lost 16 to 28 percent during this storage period and from 50 to 67 percent after an additional 24 months. Parboiled and undermilled samples apparently lost no thiamine in storage, but canned parboiled rice lost 20 to 30 percent of its thiamine in 3 months.

The effect of milling on food values was noted in Louisiana station analyses of rice and rice products for riboflavin and biotin. These analyses, together with those previously obtained on the same samples for thiamine, nicotinic acid, pantothenic acid, and pyridoxine, indicated that in general 66 to 75 percent of these B vitamins was removed in the milling process. Polished rice had only about 12 percent of the vitamin content of rice polish. This decrease in thiamine value was also observed at the California station where California-grown rice of the Caloro variety, subjected to rat-growth assay, was found to contain 3.8 micrograms of thiamine per gram of raw brown rice (only husk removed). The parboiled brown rice (prepared by preliminary soaking and steaming of the rough rice, followed by husking and drying) and the parboiled undermilled rice (prepared by a light milling of the parboiled dried rice) contained from 2.1 to 3.0 micrograms of thiamine per gram. The completely milled polished rice contained the least thiamine, namely, 0.9 microgram or less per gram.

Several varieties of Kansas-grown wheats, harvested over several crop years, and the flour experimentally milled from them were analyzed at the Kansas station for their thiamine and riboflavin content. The flours with thiamine contents of from 0.82 to 1.50 micrograms per gram retained from 12.4 to 24.5 percent of the thiamine of the wheats. The riboflavin content of the flours ranged from 0.65 to 0.96 microgram per gram, and they retained from 29.8 to 54.3 percent of the riboflavin of the wheats from which they were ground.

The effect of dehydration on food values was studied in five vegetables by the California station. The vitamin losses varied with the vitamin, being most pronounced for ascorbic acid; depended in some measure upon blanching treatment, subsequent storage, and reconstitution; and were not uniformly the same for all vegetables. For example, the dehydrated snap beans and spinach retained only 10 to 30 percent of the ascorbic acid originally present in the fresh vegetable, peas and carrots retained about 50 percent, and broccoli as much as 80 percent if blanched before dehydration but only 36 percent if unblanched.

All of these dehydrated vegetables retained from 65 to 80 percent of the original thiamine of the fresh vegetable, but broccoli showed pronounced losses after storage for 3 months at 86° F.; the dehydrated spinach similarly stored showed negligible thiamine losses in storage. For riboflavin, the retention amounted to about 65 to 80 percent for broccoli and spinach, 75 percent for snap beans, and even better than this in carrots and peas; the two latter vegetables, however, contained but little riboflavin in the fresh state, and then lost about half of what was present after dehydration in subsequent reconstitution. Most of the pantothenic acid present in the fresh spinach, peas, and carrots was retained in dehydration; about 50 percent was retained in snap beans, and 40 to 60 percent in broccoli. The dehydrated reconstituted vegetables retained about 50 to 70 percent of their nicotinic acid. The study showed that, in general, losses of ascorbic acid and thiamine were somewhat greater in unblanched dehydrated vegetables than in blanched, particularly in storage, but that this is not true of riboflavin, pantothenic acid, and nicotinic acid. Only ascorbic acid and thiamine, and to a lesser degree pantothenic acid, were found to decrease in the stored dehydrated vegetables. From certain comparisons with the cooked fresh vegetables, it appeared that riboflavin, pantothenic acid, and nicotinic acid are likely to be retained during the process of blanching and dehydrating vegetables about as well as during ordinary cooking of the fresh vegetables.

A study on snap beans at the Virginia station bore out in general the results obtained in the California study of this vegetable. In the Virginia trials, the dehydrated beans were found, in general, to be as high in phosphorus as raw beans, and higher in calcium, the latter result apparently being due to the absorption of calcium from the water in the blanching process. However, the dehydrated beans were a poor source of ascorbic acid, since only about 7 percent of the amount in the raw beans remained in the blanched beans after dehydration and storage for 6 months.

Dried chard, obtained in the Michigan station experiments by home drying of the leaves in a homemade drier used on the gas stove retained from 70 to 82 percent of the carotene and about 66 percent of the riboflavin originally present in the fresh leaves. Storage for 6 to 7 months decreased the carotene retention to only 40 percent, and reconstituting and cooking caused further loss of riboflavin up to about 50 percent of that in the fresh leaves. However, the riboflavin content of the reconstituted cooked chard

compared favorably with that of fresh chard cooked in a moderate quantity of boiling water.

Analyses of dehydrated vegetables at the Texas station to determine their content of B vitamins showed them to be good sources of riboflavin, nicotinic acid, and pantothenic acid. Dehydrated green leaf beet tops and spinach were particularly rich in riboflavin. Dehydrated root crops were relatively low in riboflavin but fairly good sources of nicotinic acid. In sweetpotatoes, the apparent loss during dehydration was about 12 percent for riboflavin, none for nicotinic acid, and 28 percent for pantothenic acid.

The effect of freezing on food values was observed in a variety of vegetables studied by the Illinois station and the Rhode Island station for changes in ascorbic acid and by the Oregon station for changes in thiamine. The prepared vegetables were blanched preliminary to freezing, quick-frozen for the required length of time, held in frozen storage for periods of from 1 to 9 months, and then subjected to cooking as they would be in home utilization of the frozen product. Ascorbic acid changes followed in these steps showed that there was some loss in the blanching step, not more than 8 and 9 percent being leached out of soybeans (Illinois) and corn (Rhode Island), respectively, but as much as 35 or 46 percent (Rhode Island and Illinois, respectively) being lost by the spinach. Cauliflower and peas at this stage lost approximately 15 percent of the ascorbic acid originally present in the raw vegetable according to the Illinois findings. Analyses at both stations showed that cut snap beans lost about 15 percent of their ascorbic acid in the blanching operation. "Frenched" snap beans, also utilized in the Illinois tests, exposed a much greater surface and had about 44 percent of their ascorbic acid dissolved out in the blanching operation. The freezing process itself caused little further change in the ascorbic acid values, but as the vegetables were held in frozen storage there was a progressive loss of the vitamin and at the end of 3 months they had lost from 30 to 50 percent of it, except for the Frenched beans which had lost slightly more, the spinach which showed much greater losses, up to 64 and 73 percent (Illinois and Rhode Island, respectively), and the soybean which had lost only 10 percent of their original ascorbic acid. Storage for as long as 9 months resulted in only an 18-percent loss for the soybeans, as much as an 80-percent loss for the spinach, and from 47- to 68-percent loss for the other vegetables tested at this period. With cooking of the frozen vegetables there were further losses of ascorbic acid (some of it to the cooking water), so that the cooked drained vegetables, using those that had been in frozen storage for 3 months, showed a loss of from 46 to 61 percent of the ascorbic acid originally present in the fresh raw vegetables, except that the Frenched beans lost more than the cut beans, the spinach lost as much as 87 percent, and the soybeans lost only 28 percent.

The study made by the Oregon station of thiamine losses during freezing and frozen storage and subsequent cooking showed that freezing plus storage caused losses of from 1 percent for Blue Lake snap beans to 48 percent for Pioneer snap beans and lima

beans. Losses in other vegetables ranged from about 4 percent for asparagus to 33 to 39 percent for vegetables such as broccoli, brussels sprouts, corn, and Swiss chard. Cooking of the frozen products caused further losses, and a substantial part of the thiamine lost from the vegetables was found in the cooking water. Total losses in freezing, storage, and subsequent cooking amounted 25 percent for Swiss chard, 44 percent for asparagus, 32 to 56 percent for snap and lima beans, 53 to 56 percent for brussels sprouts and corn, and about 65 percent for broccoli. In all cases, the cooked frozen vegetables contained considerably less thiamine than the cooked fresh.

In trials with berries at the New Hampshire station, four varieties of frozen raspberries held in frozen storage for 4 months lost from 9 to 49 percent of the ascorbic acid originally in the fresh berries before freezing. In four varieties of strawberries, these losses amounted to 16 to 37 percent in 2 months of frozen storage and increased to 54 to 99 percent after 6 months of frozen storage.

The effect of canning on food value in tomatoes is associated with the changes produced in the ascorbic acid content. A hundred samples of home-canned tomatoes collected, with their history, from housewives in Louisiana and analyzed for their ascorbic acid content at the Louisiana station laboratory showed no significant differences in the vitamin value of samples processed in the hot-water bath, those canned by the hot-pack method, and those processed under pressure. This finding was borne out by independent results at the Minnesota station, where tomatoes were canned experimentally by the open-kettle, cold-pack, and hot-pack procedures. The difference effected in ascorbic acid retention by these three methods was neither statistically nor practically significant. However, the total amount of ascorbic acid contained in the jar was higher for those samples processed by the open-kettle method than for either of the other two methods. In the Louisiana samples, tomatoes canned in tin cans had significantly higher ascorbic acid values than those canned in glass, whereas in a Maine station study experimental lots of tomato juice canned with a tin inset placed in the glass jar lost ascorbic acid less rapidly than juice similarly processed by the hot-pack method in glass jars without the tin.

The effect of the container on the retention of ascorbic acid during storage was investigated at the Massachusetts station, where the same lot of tomato juice was processed in a number of different types of containers. Of the commercial-type containers, plain tin cans and vacuum-sealed jars or bottles with tin vacuum-sealed caps or bottles with crown caps with tinfoil facing gave the best retention of ascorbic acid during processing and storage for 8 months. Of the home-canning types of glass containers, those with metal lids or with a minimum of head space were preferable for ascorbic acid retention. The difference in ascorbic acid retention between tomato juice packed in home-canning jars and that packed in tin cans was less than that reported in some previous investigations, apparently because the process time used was

sufficiently long to permit much of the entrapped air to be exhausted from the jars.

In the Minnesota station study, the tomatoes canned by the three procedures (open-kettle, hot-pack, and cold-pack) lost ascorbic acid in storage but the greatest losses came in the first 3 months of storage, and again in the interval from the ninth to the twelfth month, with smaller losses at the sixth and ninth month. After 6 months of storage the ascorbic acid loss averaged 32 percent, and after 12 months 53 percent. At the North Dakota station, losses after 6 months' storage varied from 16 to 28 percent. In experimental packs put up at the Maine station, similar trends were observed in storage losses in tomatoes canned by the hot-pack method and in juice from tomatoes sieved while hot. The tomatoes of both varieties tested (low-vitamin C and high-vitamin C varieties) lost 12 percent of their ascorbic acid in canning; the juices, 34 and 25 percent in the two varieties, respectively. In storage the greatest loss occurred in the first 30 days, but by the end of 9 months the tomatoes had lost, respectively, 60 and 48 percent and the juices 50 and 37 percent of the ascorbic acid they had when canned. Actual analyses of the canned tomatoes in these several experimental studies and also one at the North Dakota station showed the tomatoes as canned to contain 11 to 21 milligrams ascorbic acid per 100 grams; after 3 months' storage they contained 7 to 15 milligrams; after 6 months' 5 to 15 milligrams; after 9 months' 9 to 13 milligrams; and after 12 months' 6 to 10 milligrams per 100 grams.

Canning losses in Swiss chard and spinach, two varieties each, were also investigated at the Maine station. Both varieties of chard lost most of the ascorbic acid during the canning process. No additional loss occurred during storage. Both varieties of spinach lost about 40 percent of their ascorbic acid in canning, with no additional loss during storage.

A study of the effect of storage conditions and type of container on the stability of carotene in canned vegetables, as reported by the Massachusetts station, suggests that the original carotene content of fresh vegetables is stable during canning and storage.

The effect of cooking on food values has been studied in many foods—vegetables, meats, fish, and cereals in particular—and many stations have participated in these studies, some of which have dealt with large-scale cookery, some with cooking in small quantities as in the home. The results of these studies are detailed and variable, and for proper evaluation need to be summarized along with further data that will be available from studies now under way on the same commodities cooked by the various methods. A few examples will be of interest, however, to show the types of investigations involved.

Comparisons at the Hawaii station of cooking losses of thiamine from brown and partially polished rice showed that the cooked partially polished rice yielded much less thiamine than cooked brown rice. The latter lost about 12 percent of its thiamine in being washed and cooked, whereas 30 percent of its thiamine was lost in milling it to give partially polished rice and 20 percent of the remainder was lost in cooking the milled product, thus repre-

senting a total loss of a little less than half of the original thiamine content.

Packaged rolled oats of both the regular (large-flake) and the quick (small-flake) types cooked for various lengths of time were found in tests at the Wisconsin station to lose practically none of their thiamine, pantothenic acid, riboflavin, or niacin when cooked for 30 minutes or less according to normal kitchen practices.

Stewing is the basic cooking process for many meat dishes, and a desirable method for the less expensive cuts which have a high nutritive value. Preliminary results by the Texas station indicate that if the stewing liquid is used there is little if any loss of riboflavin, pantothenic acid, or niacin but about 50 percent of the thiamine is lost. If the stewing liquid is discarded, approximately 50 percent of the riboflavin, pantothenic acid, and niacin are lost but only about one-sixth of the original thiamine content is discarded with the stewing liquid. Temperature of the stewing liquid apparently has little influence on the total thiamine retention.

Temperatures at which lamb and beef roasts were cooked had little effect on loss of thiamine during the cooking process, according to findings of the Minnesota station. Roasting legs of lamb to the rare stage (79° C.)) and to the well-done stage (82°) causes the same percentage loss of thiamine (about 30 percent). Standing roasts of beef may be cooked to the medium well-done stage (71°) at 177° rather than at 149° if desired, without fear of increasing the loss of thiamine. In planning dietaries, allowance should be made for a loss during cooking of about 30 percent of the thiamine content of leg of lamb roasts and about 45 percent of that of standing beef rib roasts. A small proportion of this thiamine is recovered if the drippings are used.

The effect of the process of roasting (and of canning and corning) on the nutritive value of the proteins of beef was investigated at the Montana station by determining their biological value for growth in the rat as the experimental animal. The data showed that the processes of roasting and corning do not significantly change the digestibility and biological value of the beef proteins, but that the process of canning does lower these values slightly.

The effect of institutional cooking methods on the vitamin content of potatoes, beans, and fish was investigated at the Massachusetts station. The potatoes, pared and soaked for 6 hours, lost 5 percent of their thiamine but none of their ascorbic acid in soaking; after cooking by steaming these losses amounted to 15 and 54 percent and were increased to an over-all total of about 20 and 64 percent, respectively, by the time the steamed potatoes had been kept warm for an hour and a half by holding on a steam table. Mashing the steamed potatoes did not appear to destroy any of the thiamine but did destroy ascorbic acid; with this loss and that occurring during holding for an hour and a half, the mashed steamed potatoes lost a total of 88 percent of the ascorbic acid originally present in the raw peeled potatoes. The dry beans that were soaked, parboiled, and then baked, following the addition of a molasses-tomato-brown sugar mixture, showed some loss of pantothenic acid and niacin in the soaking and further loss of niacin and large destruction of thiamine in the baking. Calcu-

lations of the amounts of these vitamins in a cup of baked beans showed that in terms of the daily vitamin requirements of a moderately active man, the baked beans would rate as only a fair source of thiamine and niacin and a very poor source of riboflavin.

In these Massachusetts station studies, the fish, prepared in large quantity by cutting into serving portions, rolling in crumbs, and baking 30 to 40 minutes at 450° F., lost about 44 percent of the thiamine, 28 percent of the riboflavin, 29 percent of the niacin, and 33 percent of the pantothenic acid originally present in the raw fish flesh. Lean fish such as cod, haddock, cusk, pollock, and flounder were poor sources of these vitamins, but mackerel was a good source. It was estimated that a 4-ounce serving of cooked mackerel would furnish 10 percent of the daily thiamine requirements of an active man and 20 and 50 percent of his riboflavin and niacin requirements, respectively; such a serving would also furnish about 4.6 milligrams of pantothenic acid.

The nutritive value of cabbage as affected by quantity cooking procedures using various types of institution cookery equipment was given intensive study at the New York (Cornell) station. The results showed that the maximum retention of ascorbic acid in cooking would be attained by boiling the cabbage in salted water (1 quart of salted water per pound of cabbage) until just done. Steaming is also recommended for cooking cabbage, although green cabbage retained its color better by boiling. It was also shown that cooked cabbage should be served as soon as possible because ascorbic acid is lost rapidly on holding (15 percent in 15 minutes). Raw cabbage may be held without appreciable loss.

A study by the Tennessee station to determine the ascorbic acid retained by foods served student Army Air Corps units by the institution kitchens of the university gave interesting results on the ascorbic acid value of cooked frozen vegetables. The frozen green beans as received had a low ascorbic acid content and a retention of only about 9 percent in the cooked product. As a commodity they furnished a negligible quantity of the vitamin to the diet. Frozen green peas as received had quite a uniform ascorbic acid content and retained about 29 percent of the vitamin in cooking; however, the amount furnished the diet was small. Frozen Swiss chard had a low initial value and an average retention of only about 18 percent and so made an insignificant contribution of ascorbic acid to the diet. The frozen spinach retained on an average about 28 percent of its initial ascorbic acid value in cooking in the steam-jacketed kettle and made a uniform contribution to the diet amounting to 10 to 15 milligrams of ascorbic acid for each serving portion (130 grams cooked spinach).

Another study of cooking losses in an Army training camp was made at the Mississippi station. The results, obtained in some detail, suggested that when vegetables are cooked in quantity ascorbic acid losses are apt to be large, whereas carotene losses are much smaller. Fresh cabbage served as a salad contained the most ascorbic acid, boiled cabbage was next in order followed by potatoes, and reheated canned vegetables supplied the least amount of the vitamin. Losses of ascorbic acid during the serving period were found to be small in this study.

FOOD HABITS AND NUTRITIONAL STATUS

Unless people are nutrition conscious, they give little attention to food values and to selection of diets adequate to meet the body needs. How adequate or inadequate the food selection is depends then upon the availability of the food supply and upon the food habits of the people.

Food habits and physical condition of Maine grade-school children in four representative Maine communities were observed in a 4-year study by workers from the Maine station. The findings indicated that these children were not measuring up to the best nutritional standards in their diets and that this dietary inadequacy was reflected in their physical measurements and dental conditions. This led the investigators to conclude that efforts toward improving the nutritional condition of Maine people should be directed toward increasing food production and preservation and toward education in the choice of adequate diets. With the knowledge of food values in mind, it was further recommended, toward improving these diets, that special emphasis be given to the increased use of milk, fruits, and vegetables (especially those high in vitamin A and ascorbic acid), eggs, and whole-grain products. Emphasis was also given to the importance of vitamin D (and milk), especially for women during pregnancy and lactation, and for infants and children. The essential data from this technical report were utilized by the Maine State Nutrition Committee in the preparation of a summary for teachers, home demonstration agents, public health nurses, and nutritionists, showing practical applications of the findings to a complete program for the improvement of nutritional status.

A nutrition study by the West Virginia station of university students, selected at random as they passed through the examination line at the student health center, involved determinations of blood-iron content, hemoglobin values, red-blood-cell counts, and other values used as a measure of nutritional status. The values obtained for the majority of the students at the beginning of the fall term fell within normal range. However, from one-third to two-thirds showed improved values when tested again in the winter. This improvement, considered more significant than the average values found, suggested that eating habits had been improved, or that better balanced diets were being eaten. Food histories obtained from the students showed that of the iron-rich foods, which might have contributed to the improved hemoglobin values, liver was the most unpopular; 25 percent of the students expressed a dislike for it, whereas only 10 percent disliked spinach and prunes. Eggs were well eaten by men but were refused by 6 to 13 percent of the women. Bread, about one-third of which was whole wheat, was eaten in considerable quantity, and most of the men and more than half of the women drank two or more glasses of milk daily.

Freshman food likes at Nebraska, checked in a fall survey by the Nebraska station to determine dietary habits with respect to nutritionally important foods, indicated a tendency for the girls to prefer fruits and vegetables or foods high in cellulose, whereas the boys preferred the ones higher in energy; white potatoes, green peas, raw tomatoes, and leaf lettuce were liked best by boys

and girls alike; all the boys were willing to drink whole milk often, but only 84 percent of the girls expressed such willingness; and only 4 percent of either boys or girls were unwilling to eat eggs.

Food habits of Mississippi children (white and Negro) were observed by the Mississippi station in surveys which yielded information that could be turned to practical use in formulating nutritional policies or food programs for low-income groups. Information furnished by a large number of children indicated that they had very definite food preferences. Their selections suggested that serving but one type of vegetable at a meal, with rotation of the garden vegetables in the meals, would guarantee a better all-round consumption than if they were permitted to choose, meal after meal, only those they liked best. The survey indicated that a majority of white children preferred sweet milk. Negro children showed a preference for buttermilk.

A study by the Mississippi station, made during a period when there was a shortage of white corn meal in Mississippi, was aimed at determining the effect of this shortage on the consumption of other foods that "just naturally go with corn bread." Data were secured from questionnaires filled out by 1,404 white and Negro children in grades 7, 8, and 9 in 12 junior high schools. The story gathered from their answers was that they preferred corn bread made from white corn meal to that made from yellow corn meal; that corn bread was liked better than biscuits with certain foods; that Negro children liked corn bread itself better than did white children; that green vegetables, buttermilk, and beans and peas were the foods preferred with corn bread by the vast majority of the children; that the foods which would usually not be eaten in the absence of corn bread were the strong-flavored green leafy vegetables such as turnip greens, collards, and cabbage, with cowpeas, lima beans, and string beans next in order. A survey of actual consumption during the shortage of white corn meal showed that green vegetables were eaten in smaller quantities by the majority of white and Negro children, with the food intake of the latter group being more affected than that of the former by the absence of corn bread. All this suggested that when limited quantities of the favored kind of corn bread are available the consumption of other foods is affected. In the light of the observations in the course of this study, it is pointed out that a Government policy which might encourage more families to consume yellow corn meal because of its superior nutritive value might seem to be a good policy, but, that any policy must be examined for the harm it may do as well as the good. This, it is further suggested, is especially true of a policy which involves changing the food habits of a large group of low-income families, a group in which Negro families in the South would be included. For example, it is pointed out that the vitamin A in yellow corn meal will not make up for a reduced consumption of other foods such as vegetables and buttermilk.

Enriched corn meal and grits promoted in the nutrition program of South Carolina, were selected for enrichment because of the popularity of corn meal and grits in the diets of the population groups most needing the benefits of an enrichment program. Although enrichment was legalized in South Carolina, the idea

of enrichment had to be "sold" to the people. Toward meeting this problem, the South Carolina station has issued a popular circular setting forth the nutritional advantages of enrichment and offering numerous recipes for the utilization of enriched corn meal or grits in a wide variety of ways.

The culinary preparation and use of soybeans and soybean flour has likewise been the subject for presentation in a Missouri station bulletin designed to acquaint the people with the high nutritive value of soybeans and to aid in finding a place for the soybean in American diets. Suggestions, precautions, and tested recipes are presented for the use of soybeans and soybean products available on the retail market. The recipes and recommendations were developed in experimental work, and only the recipes for products rated as excellent are presented.

Blood regeneration in women blood donors was the subject of an investigation at the Nebraska station to determine the effect of generous amounts of meat and milk in the diet on the rate of blood regeneration following the donation of the usual 500 cubic centimeters of blood. Seventeen healthy young women served as blood donors and subjects on a controlled dietary regimen that furnished approximately 75 grams of protein daily following the first donation and 50 grams daily following the second donation 16 weeks later. Blood values determined at regular intervals following donation showed that regeneration, especially of hemoglobin, was significantly better on the higher protein intake but that the return to the blood values determined at the time of donation was not complete (except for serum protein) even at the end of 10 weeks. These results, it is emphasized, justify not only suggesting but urging the woman who is a blood donor (or who has hypochromic anemia and needs to build hemoglobin) to include in her diet additional quantities of meat and milk or other foods rich in animal protein and iron.

EQUIPMENT FOR HOME FOOD PREPARATION

The few equipment studies that have been reported within the year include one by the Maine station on the use of a wood cook stove converted for the use of kerosene, and studies by the Virginia station of coffee-making and electrical toast-making equipment.

The Maine investigation, undertaken to meet some of the problems of homemakers in the use of wood cook stoves equipped with oil burners, involved observations of the performance of such burners in home use and laboratory tests and measurements to determine the extent to which various conditions affected stove temperatures. The findings showed that a kitchen range can be made hotter with the use of wood than is possible with the oil burners now available on the market, but that suitable burners, properly installed, give enough heat for household cooking. Details of installation greatly affected the performance of these burners, and on the basis of these findings it was possible to suggest corrective measures for such difficulties as uneven flames, sooty flames, the spilling of kerosene over the burners when not lighted, too low a temperature on the top of the stove while the oven temperature is satisfactory, or too low an oven temperature

while the top-stove temperature is satisfactory. Installation, operational, and performance details from these tests on kerosene-burning converted cook stoves are summarized in a Maine bulletin available for convenient reference.

The study of coffee-making equipment at the Virginia station involved the use of 15 coffee makers of 3 different types and observations as to the factors concerned in the coffee-making process. The operational data obtained, together with beverage scores of a small panel of judges, indicated that high amounts of coffee with short, mild applications of water gave quality, whereas smaller amounts of coffee with longer and more vigorous action sometimes gave a strong beverage of low quality. Higher proportions of coffee (2 tablespoons per cup of water) gave best results in all cases except for percolators and appeared to be necessary with vacuum makers; with percolators 1 to 1½ tablespoons gave good results. Fine and extra-fine grinds scored high with vacuum makers, but much less so with dripolators and percolators because of the sediment. For general use in all equipment, the so-called "drip grind" was satisfactory. The vacuum makers scored the highest on the beverage produced, according to the tastes of this one small panel of judges, gave the highest yield, used the shortest contact time, handled the finest grinds of coffee, and produced acceptable temperatures, but required more coffee and were considered fragile to use and handle. Percolators worked best with medium and fine grinds, required less coffee, and gave the highest temperatures, but low yields. Dripolators took the most time, gave low yields, required higher proportions of coffee, and would not handle the finer grinds.

In the study of electrical toast making at the Virginia station, 18 household electric toasters of different makes and models, both automatic and hand-operated, were tested, using a total of 2,500 slices of standard, commercially baked bread. A combination of right temperature, time, and distance from heat was the secret of success in making good toast, the tests showed. The toasters tested varied in temperature from 253° to 547° F.; but 410° appeared to be about ideal. Too low heat made toasting slow and resulted in dry, tough toast. Too high heat caused scorching or sogginess, because it did not allow time for moisture to be driven from the surface of the bread. The time required by the different toasters varied from 50 to 96 seconds. The tests showed that successful toasting required from 1 to 1½ minutes. Because of the speed of the process, a few seconds more or less made a great difference in the quality of the toast. Some of the more expensive automatic models did not make as good toast as the cheaper, hand-operated toasters because their control devices—timers or thermostats—turned out toast either too rapidly or too slowly. In general, timers gave more accurate results than thermostats. The toaster which received the highest rating in the tests was a medium-priced automatic model, controlled by a timer. It held two slices upright in slots so that all four sides toasted evenly at the same time. It differed from the other models in that the heating wires ran vertically and the space which held the toast was larger, which apparently placed the slices at the right distance from the heat.

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